

New Methods for Detection of Fish Populations or Mapping Fish Habitat

John K. Horne
University of Washington, School of Aquatic and Fishery Sciences
Box 355020
Seattle, WA 98195
phone: (206) 221-6890 fax: (206) 685-7471 email: jhorne@u.washington.edu

Award Number: N000140510670

LONG-TERM GOALS

The overall objective of this project is to develop a new technique that detects and maps epipelagic (i.e. near surface) fishes and their habitat by integrating existing and new remote sensing technologies.

OBJECTIVES

Our specific contributions to this program will examine affects of fish distribution and movement on detected spatial distribution patterns, and to develop a technique that integrates LIDAR (LIght Detection And Ranging), acoustic, and net catch data in species-specific abundance indices or abundance estimates.

APPROACH

The research program will combine sampling and resulting data from satellites, aircraft, ships, and moorings. Each technique samples a specific range of spatial and temporal scales that may or may not overlap, and each instrument has its own advantages and constraints. The technologies and resulting data streams include:

1. Satellite AVHRR (Advanced Very High Resolution Radiometer) for sea surface temperature maps.
2. Satellite SeaWIFS (Sea-viewing Wide Field Sensor) for maps of primary productivity and sediment concentration.
3. Satellite SAR (Synthetic Aperture Radar) to identify fronts in the ocean that may be associated with salinity differences and changes in sea surface roughness and to map vessel activity.
4. Airborne radiometer for sea surface temperature along transects.
5. Airborne color radiometer for primary productivity along transects.
6. Airborne LIDAR for distribution and relative abundance of fish.
7. Airborne observers for fish distributions, relative abundance, and species identification.

8. Airborne video to record images of fish schools and individual fish, aiding in species identification.
9. Ship borne echosounder for fish densities (research vessel).
10. Ship borne CTD (Conductivity, Temperature, and Depth) for profiles and underway sampling of temperature, salinity, and density (research and commercial fishing vessels).
11. Ship borne net sampling of fish (research and commercial fishing vessels).
12. Acoustic moorings for temporal variability of fish densities.

Samples from all technologies will be used to characterize epipelagic habitat over a range of spatial and temporal scales. Satellite instruments will provide a weekly to bi-weekly synoptic picture of the oceanographic conditions and the position of river plumes. Airborne radiometers are flown under cloud cover and will provide higher spatial resolution data on conditions where fish are detected. Instruments deployed from the ship provide calibrated measurements but are restricted to volumes below the vessel.

A combination of LIDAR, acoustic, and trawls will be used to sample fish communities. LIDAR measurements will be used to compile synoptic, large-scale view of fish distribution and densities. Aerial observers will provide a coarse quantification of fish school distribution and species identification. Echosounder data will be used to compile a regional picture based on measurements along the cruise track. Synopticity of acoustic data will be less than that from the LIDAR data and near surface concentrations of fish may not be included. Multiple aerial surveys will be performed during acoustic surveys to track temporal changes in fish distributions. Temporal variability in the density of fish will also be measured using acoustic moorings to get continuous time series at three locations. Aerial and ship-directed sampling by nets deployed from research and commercial vessels will provide species identification and length distribution data.

A Geographic Information System (GIS) will be used to analyze and visualize relationships among fish species and their habitat. Geostatistical analyses will be used to determine spatial scales of autocorrelation and spatial overlap among ecosystem components. Spatial regression modeling will be used to quantify relationships among components. The project aims to integrate all data from LIDAR, acoustics, and trawl catches.

WORK COMPLETED

An initial cruise was conducted during August 2005 and successfully collected acoustic and LIDAR data. Data summaries and initial data processing have been completed. Acoustic, LIDAR, trawl catch, and visual observation data are being geo-referenced for comparison using geostatistical methods.

RESULTS

Acoustic transects and coincident LIDAR overflights were surveyed from August 21 through August 28, 2005 off the coast of Washington and Oregon (Fig. 1). Transects followed five predetermined routes along latitudes 44.67°, 45.48°, 46.17°, 46.67°, and 47.00° north extending from 5 to 48 km offshore.

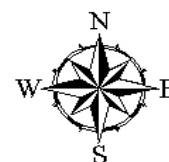
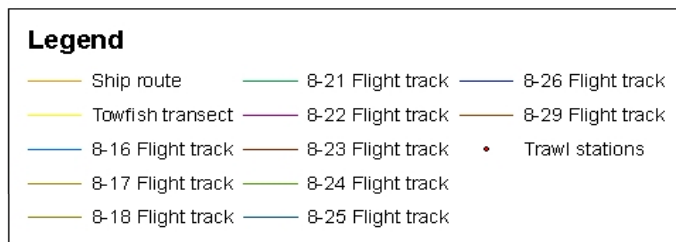
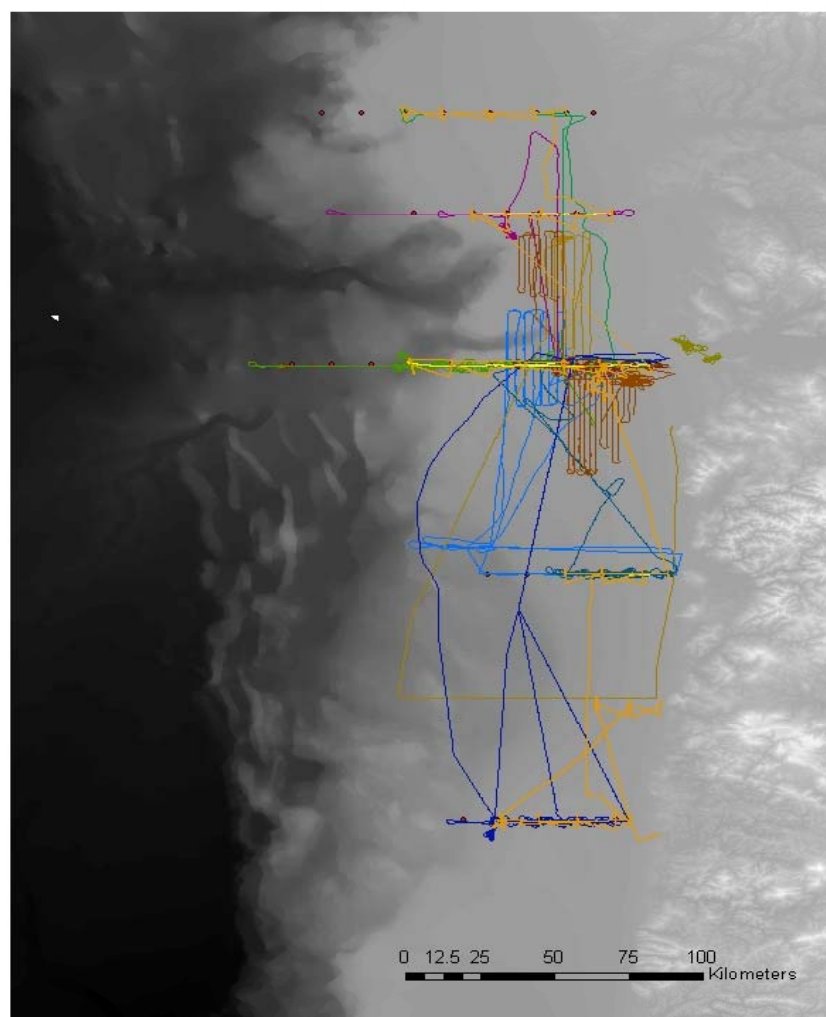


Figure 1. Acoustic and LIDAR transects sampled during August 2005 between latitudes 44.67°N and 47.00°N.

Two acoustic frequencies were used during the survey. Both 120 kHz and 38 kHz transducers were deployed on a towfish that surveyed approximately 160 linear kilometers. To supplement acoustic coverage, the ship's echosounder operating at 38 kHz was used during an additional 3480 linear kilometers. Approximately 2800 km of the ship track coincided with LIDAR over-flights.

A total of 8086 km LIDAR sampling was conducted from August 16 to and August 29, 2005. Survey grids covering approximately 5475 km were flown concurrently with the acoustic sampling while the towfish was deployed during late afternoon (Fig. 2). LIDAR grid samples were composed of an average of 15 parallel passes along each acoustic transect, each pass offset by 200 meters. The remaining 2611 km were flown prior to the acoustic survey, at night, and during LIDAR calibration trials.

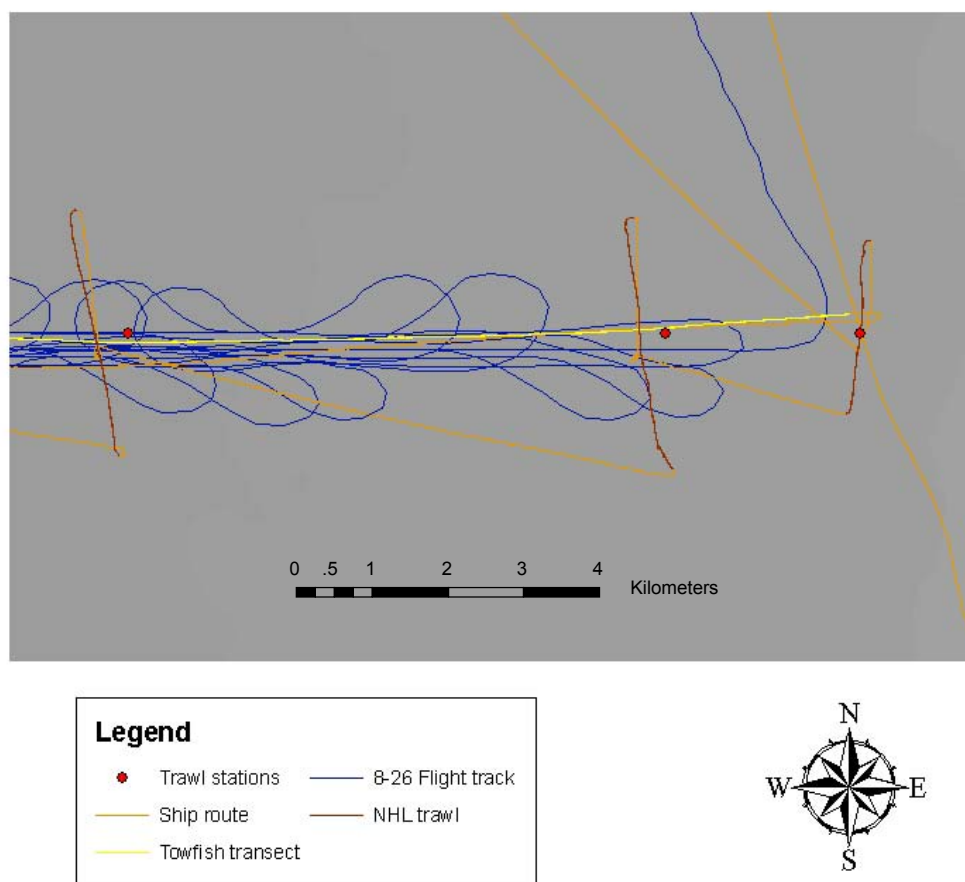


Figure 2. Detail of the Newport Hydro Line (NHL) transect at latitude 44.67°N. Note multiple passes of the LIDAR aircraft (blue) along the towfish route (yellow), each pass offset by approximately 200m. Vertical segments brown in color are associated trawls for the acoustic and LIDAR transects.

Midwater trawl hauls near the surface were conducted at three to five stations per transect to provide species and size compositions of resident fish fauna. Trawl catches consisted of juvenile salmon, anchovy, and sardine. Each transect was trawled for 30 minutes and averaged 3 km in length.

Flights to calibrate optical backscatter from the LIDAR system were conducted on August 18, 22, 24, 25, and 26. The last flight was conducted at night. Few direct samples were obtained on the calibration sphere as the 4 inch diameter target proved too difficult to acquire with the LIDAR instrument. Redesign of calibration experiment and execution will take place during spring 2006.

IMPACT/APPLICATIONS

Integration of acoustic and LIDAR sampling technologies will improve coverage of the water column and potentially increase synopticity of aquatic surveys. Calibration of LIDAR equipment will make direct data comparisons easier.

RELATED PROJECTS

This project is a component of the NOPP sponsored program. All project components are coordinated among PI's J. Churnside, R. Brodeur, E. Brown, K. Benoit-Bird, and J. Horne. This research program conducts fieldwork in the same area as future sampling planned for the NOPP sponsored project, "Development of mid-frequency multibeam sonar for fisheries applications" (J. Horne and C. Jones).